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COVER: Wheat, "the staff of life," economically important member of the grass family. Photo by George V. Van Schaack.

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Missouri Botanical Garden Bulletin

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TROPICAL WATER LILIES

GEORGE WM. PRING*

THE hybridizing of tropical water lilies—as representative of the flowering seed plants—results under normal conditions in numerous, differing offspring. These resultant generations of unique plants, having varying dominant characteristics, can be of fascinating and challenging interest to the amateur grower as well as to the professional hybridist. During the past century, man, by cross-pollination, has produced countless new horticultural plants, among them, many varieties of water lilies in an astounding array of colors, physical characters, growing habits and quality. The basic technique of hybridizing the family of water lilies is simple enough to be mastered adequately by the casual grower. Without the expert's knowledge of genetics and the Mendelian Laws of heredity, the amateur grower's possibilities in cross-pollinating are limited. Experimentation by trial-and-error will be the guide of the novice whereas the professional hybridist can apply fact and theory in planning long-range crosses. The challenge is not lessened for the beginner; his opportunities simply must be more limited.

The family of tropical water lilies has three distinct methods of reproduction; the first two, budding by tubers and by viviparous leaf reproduction, are useful only in increasing the grower's stock of plants already on hand. It is the third and final method, involving sexual reproduction, that offers the professional and novice alike the opportunity to propagate totally new offspring.

The flower of *Nymphaea* is perfect, having both the stamens and pistils located in each flower. Sexual reproduction is achieved when the pollen grains from the stamens fertilize the ovules contained in the carpel, producing a zygote, which gives rise to the seed. The pistils are located in the center of the flower; they are cup-shaped and hold the scented nectar, which draws insects to pollinate the flower. The insects, upon smelling the nectar, plunge directly into the pool. As they struggle and drown, pollen grains which have adhered to their bodies sink to the base of the pistil, the receptive stigma.

The pistil is the upper portion of the carpellary structure housing the ovules, or female eggs. The carpels, averaging 28–30 per flower, are linked compartments which together form a spherical pod, the base of the female reproductive organ. When the pollen

* Tropical Water Lilies by George Wm. Pring, grandson of George H. Pring, Superintendent of The Garden. Written in the course of his studies at Harvard University under a scholarship.

grain settles on the stigmatic surface it sends down a filament carrying the male reproductive elements. A seed is formed when this reproductive cell fertilizes the female ovule; each seed is theoretically capable of reproducing another complete plant. At the close of the fertilizing stage the carpellary sphere hardens, forming a protective pod for the maturing seeds.

Encircling the pistils in concentric rows are the stamens, terete rods supporting the pollen heads. On the first day of the flower's opening, the stamens are vertical, exposing the nectar-filled pistil. On the second day the inner, shorter stamens arch over to cover the pistil, and the longer, outer stamens curve outward. On the fourth day the stamens return to a reflex position, exposing the dried pistil containing the bodies of dead insects, trapped after their role in the *Nymphaea* life cycle has been completed.

The basic problem in fertilizing the distinct plants is to bring the pollen of one to a successful contact without contamination to the ovules of the other. Because of the dominance of specific hereditary traits, it is highly important which of the selected plants is chosen to be the pollen-parent, and which the seed-parent. To bring out the greatest number of variances, reciprocal crosses, that is using each plant as the female in separate pollinations, is recommended.

A few general cautions should be observed in cross-pollination: maximum care must be taken to insure that no stray pollen grains will interfere with the planned pollen-cross; the pollination should take place on the first day of the female seed-parent's opening while the nectar cup is full; one should remember that the most highly receptive period in the *Nymphaea* life cycle is from 10:00 A. M. to 12:00 Noon, during August.

The tropical water lily growing season extends from May 15 in the Midwest or June 1 in the East to the first killing frost, usually in October. Two days before the female parent is expected to flower, the bud must be gently opened and all the stamens should be removed by hand; this step prevents the flowers own pollen from contaminating the delicate cross. No nectar must have formed in the pistil when the flower is emasculated. After all stamens have been removed, the bud is clamped tightly with rubber bands and is covered completely with gauze, a further precaution against unwanted pollen.

On the day of pollination, sufficient stamens (6–8) should be removed from the male parent; these are placed in the stigma of the female (which by now must be filled with nectar for an effective cross) and are agitated to release the pollen. Care must be taken that these pollen grains do not get mixed with other pollen; a small glass vial may be used to transport the stamens to the seed-parent. Repeating the protective process, the pollinated female must be closed, bound with rubber bands and covered with fresh gauze.

The peduncle of the plant should be attached to a stake, for after fertilization takes place, the stem bends in an S-shape and plunges the bud into the water. The stake provides the grower

with a constant check on the seedpod's location. If fertilization does not take place, the flower reenters the water and will gradually decay. In three weeks, usually in early September, the fertilized pod ripens and rises to the surface to open, scattering the ripe seeds. The gauze covering, if kept firmly in place, will prevent the loss of seeds until they can be collected and stored in a jar of water. Here the individual seeds lose their gelatinous coating and sink to the bottom. When settled, they should be removed, dried for two days, planted in sandy soil and placed in a tank of water kept at 75–80° F.

Floating leaves develop in the seedling tanks during late September and early October, provided the temperature is kept at a constant 75–80° F. The leafy plants may then be transferred to pots, where they should be nurtured in warm water until May or June of the following spring. The result of the experimental cross—the new crop of flowers produced—can be examined in July or August. One of the most rewarding features of work with the *Nymphaea* family is that the period of waiting for the hybrid to develop is comparatively short; similar work with orchids can take as long as four to six years.

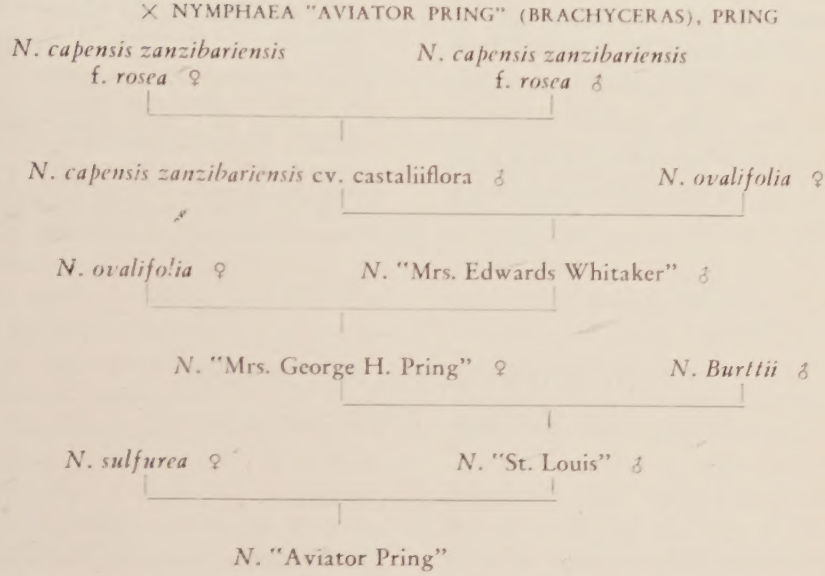
Thus far, the physical methods of controlled reproduction have been dealt with specifically, while the results of this work have been relegated to a more general treatment. But it is actually the result of this process, not the process itself, which is of primary interest to the interested grower. If the grower has a favorite color in a lily produced on a plant of poor growing characteristics he could, by cross-pollination, combine the desired color with a strong growing character in another plant. It is possible that some percentage of the offspring of his chosen parents would combine the characters of good color and strong growth.

The process of producing the world's first albino tropical involved just such manipulation. The introduction of *Nymphaea ovalifolia* — a vigorous grower, having white flowers with blue tips, but few petals—gave the hybridist a logical starting point. To increase the number of petals *N. ovalifolia* was crossed with *N. castaliiflora*, a many-petaled hybrid, producing an F_1 generation with light blue flowers and a sufficient increase in the number of petals.

It was noted that some of the F_1 generation bleached white after being open several days. These plants were re-crossed with the parent *N. ovalifolia*, producing an F_2 generation with dominant white characteristics. This hybrid was carefully self-pollinated for two years to bring out the pure color, and during the summer of 1922 the world's first tropical day blooming albino—*N.* "Mrs. George H. Pring"—was successfully produced. The pink and blue traits of its parents were eliminated. George H. Pring, superintendent of the Missouri Botanical Garden, produced this hybrid, which was named for Mrs. Pring.

The little-known species *N. Burttii*, a natural small flower of primrose-yellow color, stimulated a search in 1930 for a full yellow hybrid. Before

Nymphaea burtii, the pollen parent, *N.* "Mrs. George H. Pring," the seed parent, and *N.* "St. Louis," the offspring.


× NYMPHAEA "AVIATOR PRING" (BRACHYCERAS), PRING
N. capensis zanzibariensis f. rosea ♀
N. capensis zanzibariensis f. rosea ♂
N. capensis zanzibariensis cv. castaliiflora ♂
N. ovalifolia ♀
N. ovalifolia ♀
N. "Mrs. Edwards Whitaker" ♂
N. "Mrs. George H. Pring" ♀
N. Burttii ♂
N. sulfurea ♀
N. "St. Louis" ♂
N. "Aviator Pring"

the introduction of the African yellow into the U. S. through the efforts of George H. Pring it was thought impossible for the genes of the tropical water lily to form the yellow pigment. When *N. Burttii* was pollinated with the original white species (*N.* "Mrs. George H. Pring"), the offspring showed dominant yellow characteristics. Other colors detected—blue, white and pink—were traceable to the parentage of *N. Burttii* and that of the albino, but were recessive. By cautious, planned crossing between the original white and the yellow the first commercially-practical yellow hybrid was produced, *N.* "Aviator Pring." The plant was named by George H. Pring for a son who died in World War II. (The enclosed diagram of two hybrids illustrates their relation and derivation.)

An expert will seldom encourage seed reproduction for an amateur seeking only to increase his stock of lilies, for commercially produced hybrids are available in widely varied colors and sizes and at a reasonable cost. Needless to say, stocking one's pond with commercial hybrids is less difficult than developing one's own species, by trial and error.* But for the water lily fancier who desires to experiment with heredity in bringing out certain desirable traits in his plants, hybrid-

*One instance of the odds against the hybridist is the fact that of the 246 pollinations using the yellow hybrid of *N. Burttii* as a parent only eight acceptable new hybrids were produced. See the MISSOURI BOTANICAL GARDEN BULLETIN, XXII, (February, 1934), p. 50.

ization is a useful and fascinating process. Time and increased study of genetics will enable the grower to look beyond one succeeding generation, giving him a larger field of operation: like the once "impossible" objective of producing the first albino hybrid from colored tropicals.

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THE BOTANIST'S CONTRIBUTION TO TIMBER CONSERVATION

TRIFON VON SCHRENK

THE term "Conservation" as it is commonly employed, usually refers to such matters as keeping our national resources from becoming depleted, either by setting aside certain areas or by restricting the use of various natural products or by employment of improved methods of control. Such conservation measures are among the direct approaches toward saving our national assets. The indirect approaches toward the same objective are not always so obvious and it is probable that the general public is not fully aware of what has been done in the past fifty years and what is still being accomplished along lines that are perhaps not spectacular but nevertheless of great significance. A synonym for conservation is "preservation." Any effort to preserve one of our resources, that is, make it do service over a greater period of time than would otherwise be the case, is a contribution to conservation.

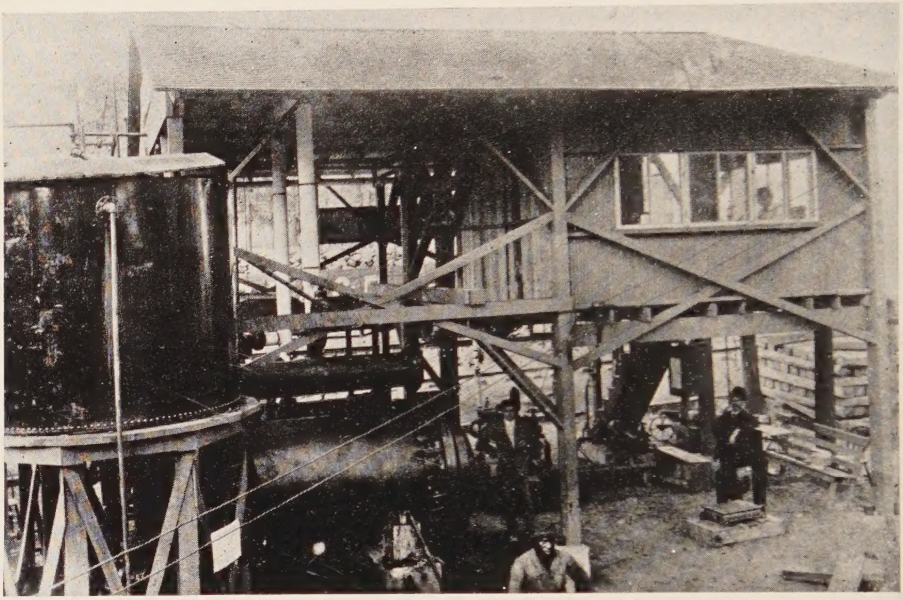
From earliest times, man has tried to preserve timber from the ravages of decay and insect attack. For many centuries the motive for making wood last longer did not involve any consideration of saving trees. The objective was rather to postpone the date on which a structure would have to be rebuilt. The question of transportation of wood to the building site was also a factor. It was not until it became apparent that timber was getting scarcer or more remote, that real efforts were made to give more lasting protection to wooden structures. Pitch and bitumen had of course been in use for sealing and waterproofing since earliest times and it is conceivable that the early experimenters were influenced by Biblical, Egyptian and other ancient accounts. Such coatings, cements of various kinds and paints and varnishes came to be used. These surface applications did much to prolong the useful life of wood, and to this day, the

development of surface protectives continues to form the basis of a large industry.

The cause of decay in wood was never clearly understood until the problem was investigated by the botanists. Long continued studies by mycologists and plant pathologists, to which scientists at Missouri Botanical Garden made noteworthy contributions, finally established the fact that so-called wood rot was due to saprophytic and sometimes to parasitic organisms or fungi which use the wood as food, thereby breaking down its structure and causing it to collapse under load. It is not the purpose of this article to deal with the intricate physical and chemical processes involved in the destruction of wood by fungi and by animal forms. It is sufficient to note here that the recognition of the causes for wood deterioration led men to think of ways and means to counteract them. If a means could be found to make a bridge timber resist decay for twenty to thirty or more years, a threefold gain was in prospect, namely—a saving in repair and replacement costs, a safer structure, and last but not least, conservation of the available timber growing in the forests.

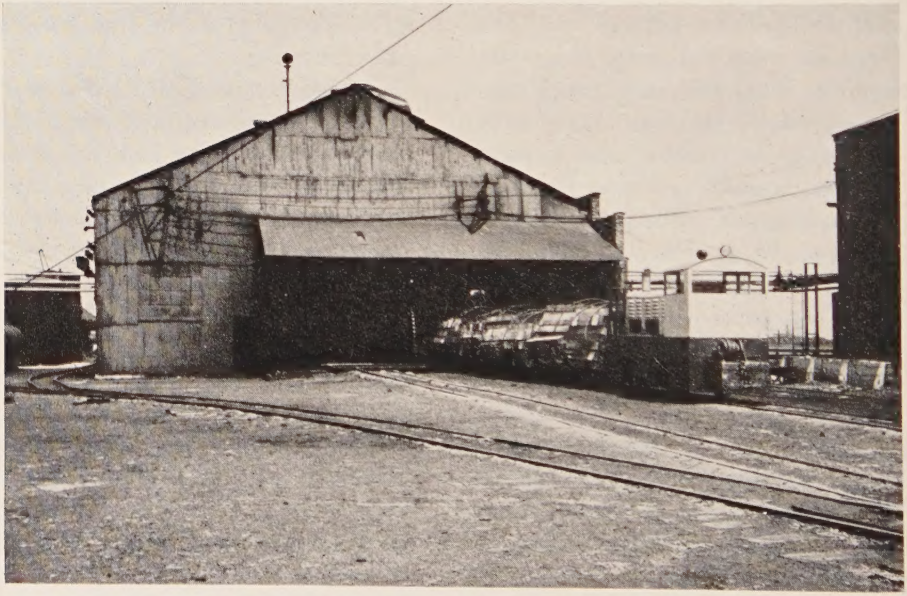
The diminishing supply of timber was felt in England and on the Continent long before we in the United States had any such experience. As a result, the Europeans applied themselves to the question of timber preservation long before we did. During the latter half of the last century the question of labor costs in those countries was nominal when compared to the high cost of their materials, and this is to some extent still the case. The growing scarcity of timber encouraged extensive reforestation on the one hand and on the other hand gave impetus to increasing efforts to find some chemical or chemical compounds that would successfully check the work of the wood-destroying agents. It was found eventually that treatment with solutions of some of the chemical salts and of "tar oil" and of creosote, went a long way towards extending the useful life of a piece of wood. Volumes would be required to describe the details of all the tests that were made with various compounds, including the use of common salt to preserve coal mine props in Bohemia and trials with sugar solutions in India. We are indeed indebted to those early pioneers in Europe and elsewhere for much of the basic knowledge on which our later research has been built.

Two important aspects were realized as men gained in experience. First—the material added to the wood had to be sufficiently toxic to inhibit the growth of fungi or kill the fungi; second—a surface painting was of short protective value for wood that was continuously exposed out-of-doors. Paints did very well for the sides of houses. Repainting such structures every few years was not too much of a problem, but bridge timbers, railroad ties, piles, telephone and telegraph poles and fence posts, constituted a class of wood products that were exposed to unusually severe conditions. Most of them were in contact with the soil and when they failed it was expensive to



1904 St. Louis World's Fair Experimental Timber Treating Plant

PHOTO BY H. VON SCHRENK



Ties being introduced into treating cylinder at a modern timber treating plant.

PHOTO BY E.L.E.

replace them. It was found that decay was greatest at or just below the ground line where conditions of temperature and moisture were most favorable for the growth of wood destroying organisms. Painting would not give enough protection here. The best answer was found in pressure treatment, by which is meant a process of injecting a toxic solution into the wood to the greatest effective depth and in predetermined amounts.

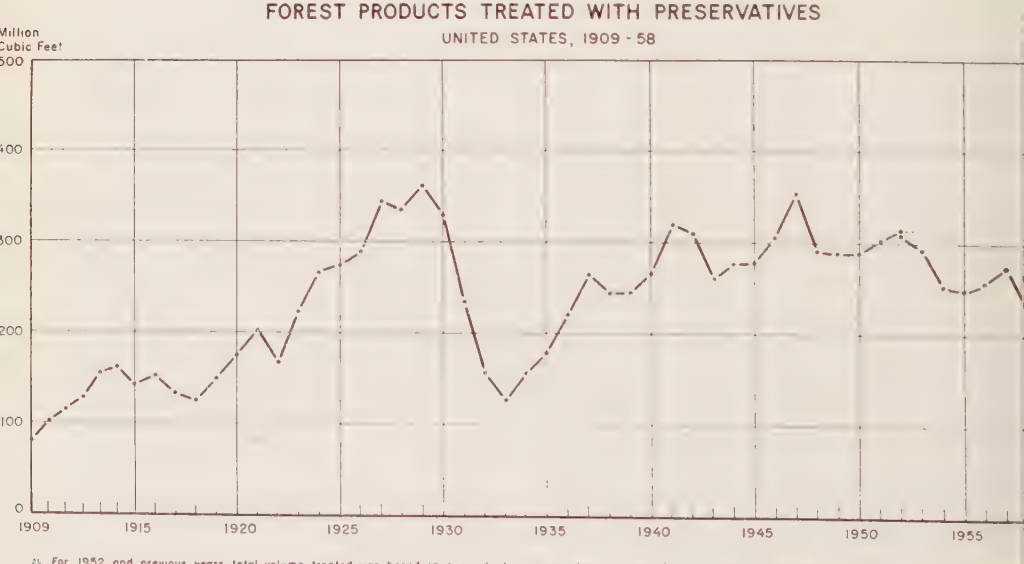
Briefly, pressure treatment of timber involves removal of bark, seasoning, either by air drying or by various other means, and enclosing the wood in sealed horizontal cylinders where it is exposed to the heated treating solution under pressure. At some stages a partial vacuum is created in the cylinder. When a sufficient number of hours have elapsed, the pressure is released and the treated wood is withdrawn, either with or without a final vacuum treatment. Throughout these operations, careful watch is kept over the temperatures, pressures, vacuums and quantities of preservative injected. Specific variation and sequences of these factors form the bases for a number of patented processes.

Creosote derived from coal tar was for many years the principal product relied upon in pressure treatment. It is a by-product resulting from the destructive distillation of bituminous coal during the coke making process at steel mills, and should not be confused with wood-creosote which is derived from the distillation of wood. Later it was found that for some purposes, equally acceptable results could be obtained by mixing creosote with coal tar in various proportions, at important savings in material costs. Concurrently, progress was made with water soluble salts and these are also used today in considerable quantities. In these, important roles are played by zinc, copper, chromium, arsenic, fluorine, chlorine, ammonium, phosphorous, dinitrophenol, boron and other chemicals. Pentachlorophenol dissolved in petroleum has proven to be an excellent preservative also and its use is likewise on the increase. Light and heavy petroleums are in use as solvents and extenders and other properties are being studied.

It should be borne in mind that creosote treatment, directed primarily to prevent fungus attack, is also effective in proper retentions, in protecting wood against termites and marine organisms, known colloquially as ship worms. Powder-post beetles and carpenter ants are also among the wood destroyers that are warded off. Treatment of wood to make it resistant to fire should be mentioned here since efforts along that line are likewise of great economic importance, and, from the conservationist's point of view, constitute another of the indirect approaches mentioned previously.

In order to bring into focus what significance should be attached to timber treatment when we speak of conservation, the following table is abstracted from Vol. 55 of the Proceedings of the American Wood Preservers' Association. It shows the amounts of timber treated per year in the five year period, 1954 to 1958 inclusive. These figures are represented graphically on the chart which fol-

lows, taken from the same source. It will be noted that the figures are given in cubic feet of wood treated. Multiplying by 12 gives the equivalents in board feet measure. If this is done for the year 1957, we find that 274,500,000 cu. ft., or over 3¼ billion board feet of wood were treated during that year. All of this wood will serve from 15 to 35 years and a large proportion will probably last much longer. As we know, wood in these categories, in the untreated state, would last a mere fraction of that time. The figures indicate the length of time made available to us through chemical treatment, in which we may grow new trees of equivalent use value. We are also led to think of how the value of our investment in this treated wood at 1957 prices will continue to increase over the years to come, commensurate with the upward trend of the labor and materials costs curves. That the importance of timber treatment has received ever growing recognition, is shown on the chart by the rise of the curve from 1909 to 1929 and by a similar rise starting in 1934 after recovery from the 1929 depression period. Year to year minor fluctuations are largely due to economic conditions of one kind or another. The recent downward trend of the curve may be attributed largely to the reduced spending forced upon our railroads, a subject on which a large volume could be written. The drop may also be interpreted in part as reflecting the cumulative effect of treatment over the years. The implications as to conservation are obvious. In 1958 we had 369 timber treating plants, including both pressure and non-pressure plants, most of them commercially owned, serving various



From Proceedings of American Wood Preservers' Association Vol. 55, 1959, page 258

MATERIALS TREATED IN THE UNITED STATES 1954–1958
IN CUBIC FEET INCLUDING ALL PRESERVATIVES

Year	Crossties	Switch Ties	Piles	Poles	Wood Blocks
1954	105,529,303	7,422,255	12,317,768	63,873,288	2,768,472
1955	85,918,977	7,256,684	13,934,824	74,765,763	2,817,302
1956	83,226,387	8,068,118	16,845,129	85,805,108	1,807,244
1957	101,529,365	8,065,851	16,269,644	84,021,451	1,598,823
1958	73,934,502	6,667,996	16,188,133	73,813,322	(1)

Year	Crossarms	Lumber and Timbers	Fence Posts	All Others	Total
1954	3,743,192	37,006,274	15,231,700	2,770,445	250,662,697
1955	4,330,044	39,433,212	16,226,742	3,761,227	248,444,775
1956	4,686,087	41,030,788	12,770,058	3,612,412	257,851,331
1957	4,601,566	41,874,651	13,384,478	3,155,620	274,501,449
1958	3,367,362	39,105,229	14,890,212	4,811,663	232,778,419

(1) Included in "All Other" in 1958.
Abstracted from Proceedings of American Wood Preservers' Association Vol. 55, 1959, page 270.

industries, the balance being railroad owned. Many of the treating companies have been practicing scientific forestry on their own large timber tracts—an additional noteworthy contribution to conservation.

Studies of chemicals and methods of evaluating the results of treatment are being pursued continuously by Government agencies, by private corporations and individuals and by large organizations such as the American Society for Testing Materials, the American Railway Engineering Association and the American Wood Preservers' Association. The work at Missouri Botanical Garden in the early 1900's was largely responsible for the formation of the last named group, an organization of men who have fostered the underlying principles discussed above. Studies in plant pathology at institutions of learning continue to advance our knowledge of cause and effect. An enormous amount of work is being done by committees of associations such as those named above and by individuals and corporations, on a great many problems other than the decay factors, that have a bearing on the durability of wood in use. This necessarily brief mention does not do justice to the scope and importance of those endeavors. They all contribute to the over-all effort to use our available wood in the wisest ways possible.

This story has of course been recounted frequently in technical publications and is a familiar one to the timber treater. It is presented here to the readers of the BULLETIN because it illustrates the far reaching effects on our economy that may result from purely academic studies in the natural sciences.

It may on first consideration appear paradoxical that a man whose self interest is served by cutting down trees may be found in the front rank of conservationists who are doing everything possible to prevent the destruction of our trees. It is hoped that what has been said above may serve to make clear how this seeming contradiction may be resolved by showing how the fundamental work of the botanists and other biologists has enabled the consumer to arrive at long-range appraisals of wood consumption and wood replacement. To maintain the balance, wood conservation through wood preservation has given us a large part of the answer. While certain exceptionally resistant or useful species, such as tidewater red cypress, long leaf yellow pine and northern white pine, are now the subjects of nostalgic conversations about the good old times, we may nevertheless look into the future feeling assured that we will continue to have all the wood we will need as long as we continue on the alert in the cooperative work between scientist, processer and consumer, as herein sketched.

THE GRASSES

The grass has been growing again for several weeks, and anyone who confesses to know something about grasses has heard more than once, "You're just the person to tell me what to do about my lawn." As well he should have heard, "You're just the person to tell me what to do about my cottage cheese," or beer, or bamboo fishing pole, or sugar, or sirloin steak, or bourbon highball, or bread and so on and on.

Stand at the checkout counter of a supermarket someday and watch the grasses as they pass. Essentially all the meat (from forage-matured and grain-fattened cattle, corn- and milk-fed pigs), all the dairy products, all the poultry products, all the bread and cereals, most of the sugar, are directly the product of grass. Certainly in the temperate zone and cooler tropics seventy-five percent of all human energy is obtained by eating grass directly as bread, cereal or sugar, or indirectly in meat, dairy products, and the like. In our own plush civilization we mix our grass with large amounts of the vitamin foods, fruit, fresh vegetables and so on. But this is not a universal practice. In parts of India, for example, the poorer people eat the same meal three times a day, a gray porridge, boiled up from the tiny seeds of a relative of the goosefoot grass, which grows as a weed in our sidewalks, about as appetizing as last night's dishwater, although lots more nourishing. In eastern Asia and Indonesia, the grass may be more palatable, rice, three times a day, if you're well-off, or the cheaper millet if you're not, and not too much besides.

Most of the world's alcoholic drinks are derived from grass. Beer from barley (John Barleycorn) and other grains, whiskey chiefly from corn (bourbon), rye (rye) or barley (scotch), sake from rice, chicha (in the Andes) from corn. Industrial

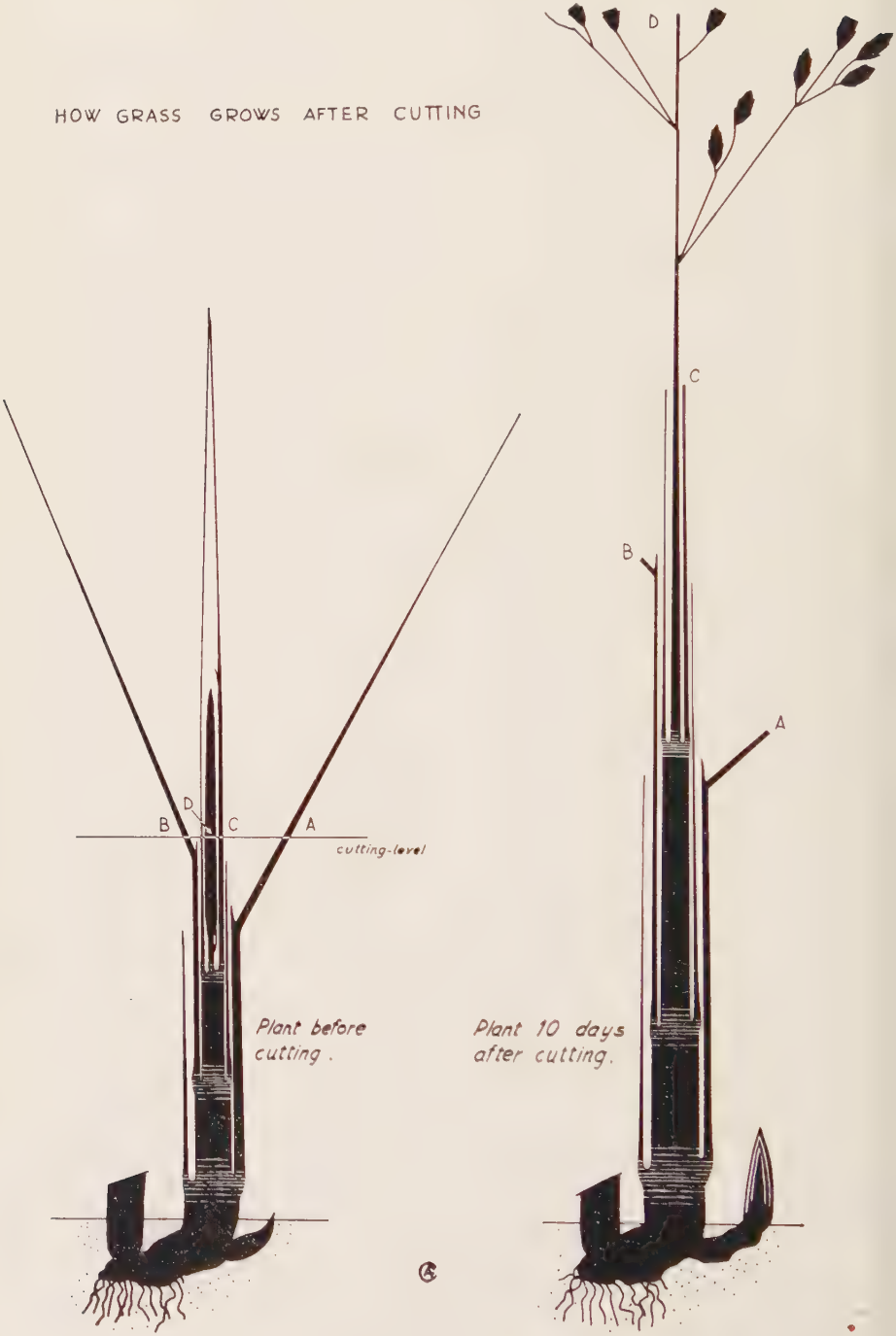
ethyl alcohol is made almost entirely from grass, whence its common name, grain alcohol.

Here and there over the earth there are small, or even larger groups of people who live without depending on grass. The Eskimos of the north live on fish, many central Africans subsist on palms, river Indians in South America on cassava, and there are others. But these groups are all relatively small compared to the concentrated populations of industrial Europe, Asia and America and the untold millions of Chinese and Indonesians. India is a somewhat conspicuous exception. Here, it is true, much rice, millet, sorghum and corocana (goosefoot) are eaten, but probably more important are the fruits of many other plants with small seeds and those of a great variety of legumes. Not only does grass sustain all industrial civilizations today, but scarcely any important civilization developed far until grass became its staple. In China it was rice, in India millet and sorghum, in the Tigris-Euphrates and Egypt wheat; in Greece and Rome wheat again, and other grains; further north in Europe rye and barley; in Mexico and Peru it was maize, or Indian corn.

What is it about grass that has granted it this ascendancy? It is several things, of which perhaps the three most important are: Its phenomenal yield, the way it branches at the base, and its growth-habit above ground. From one grain of wheat a plant producing five hundred or more grains can be grown; a kernel of corn may grow into a plant producing three or four thousand grains. Some wild grasses will produce from a single seed up to twenty-five thousand seeds in the first season! These yields are beyond anything found in any other generally adaptable group of plants with useful fruit, both palatable and wide-ranging in variety.

Some grasses, notably several of the cereals such as corn and wheat, branch repeatedly at the base. This habit, known as 'tillering,' enables a single seed to produce very quickly a plant with many almost equal shoots, all growing at the same rate and ready to yield about equally. Beans, tomatoes and many other vegetables branch, it it true, but *above* the base, the branches being dependent on the main stem in a way that the tillers of a grass are not. Some authorities have considered tillering, which among cultivated plants is restricted to grasses, to be more important to the dominance of grass than all other characters peculiar to this group combined. Other grasses branch at the base to form underground stems, or rhizomes, thus spreading out to form turf. Bluegrass is a typical example, and it is this turf-forming tendency which makes it so desirable as a lawn grass, and, more importantly, as a field and forage grass.

Finally, grasses grow *from down below* instead of *up on top.* Cut off the top of a young cabbage plant and you lose your cabbage. Cut off the top of a young wheat plant and you lose essentially nothing. The plant is growing at the *bases* of the leaves and the treasure of the wheathead is still forming way down inside, protected by many layers of leaves. It is this



DRAWING BY COCUCCI

'way of life' which makes grass so great a forage plant—as it is chewed off from the top it grows up from below, in fact, up to a point some grasses seem to be stimulated to extra vigorous growth by being cropped.

So this year don't cut *all* your lawn down to one and a half or two inches. Do a little experimenting in cutting-heights on the back lawn and take note of how the plants behave. Especially, save at least a small plot where you don't cut at all, but just watch what happens. If you look sensitively and reflectively you won't be disappointed.

—G.B.V S.

A GARDEN CONTRIBUTION TO SECONDARY-SCHOOL EDUCATION IN THE ST. LOUIS AREA

When the Congress of the United States established the National Science Foundation in 1950 with an initial budget of $3.5 million, programs were initiated which last year were successful enough to warrant a budget of 155 million. The justifying steps leading up to this latter figure cannot be retraced, in the opinion of the Chairman of the National Science Board, Mr. D. W. Bronk. There of course have been fears of dictation of science from Washington, but they have not been realized. Rather than stifling private efforts in the field of science support, this federal money has actually stimulated such sources to provide more and more money for research and education. All these monies mean a greater opportunity than ever for scientists.

From where will they come? There is an alarming dearth of trained teachers, and no prospect that the requisite number will be forthcoming, according to Dr. Alan T. Waterman, Director of the National Science Foundation. He continues his 1959 Annual Report by noting that the teaching of basic aspects of science and engineering must be stressed. He even comments that quite possibly such teaching may be a more important activity than furthering research by already qualified individuals. Congress has earmarked considerable sums specifically for improvement of the level of high-school instruction.

One of the many teacher-training programs administered by the National Science Foundation is that of the In-Service Institutes. These sessions provide high-school teachers with a sort of "on-the-job training," in that they are for specific subjects in the sciences. Participants receive no stipends, but are given small travel allowances. This procedure favors the premise that only dedicated teachers interested in learning will apply. During the 1959-60 school year, about 9000 secondary school teachers had an opportunity for further study under this program. There were 320 Institutes of this type held throughout the

country. The Garden was chosen by the Foundation to be one of this number.

Our Institute was for one college semester in Botanical subjects. Each Wednesday night in the small room of the Museum, twenty biology teachers spent from 7:30 until 10 tearing plants apart and discussing knowledge gained, teaching methods used and ways to introduce some of these exercises into their own classroom curricula. One session was a Saturday trip around the Garden to study possibilities open for class excursions. Six sessions were devoted to topics of plant structure, seeds and their germination, twig identification and plant cell division. Four sessions covered topics in environmental control of plant growth, the physiology of growth control, respiration and photosynthesis. One meeting considered the greenhouse plant collections and their utilization in classroom study; another went into details of construction and management of an inexpensive "basement greenhouse." This latter topic proved so popular that we are about to undertake a separate and greatly expanded program to make this knowledge available to high schools throughout the country. Two sessions were devoted to the study of coal-age plants, complete with take-home specimens of 250-million-year-old plants.

We were visited in early December by Mr. Albert Young, a member of the Science Foundation staff, who was profoundly impressed with the enthusiasm displayed by our group. But after all, they were receiving first-hand give-and-take instruction from such people as Henry Andrews, Frits Went and Edgar Anderson, all world leaders in their fields and excellent teachers as well. Each of these men is vitally interested not only in his own work but also in the problems of teaching. How could there help but be enthusiasm?

At the close of the Institute, we asked for letters of evaluation from the participants. These letters not only made heart-warming comments on our efforts; they added valuable constructive criticisms as well. Selected portions of their comments were included in our report to Washington, where they will help decide National Science Foundation policies in the coming years.

Encouraged by our apparent success, we enlisted the aid of members of the Department of Zoology by Washington University, and submitted a proposal for an In-Service Institute in Biology for the full academic year 1960-61. Notification has just been received of its acceptance by the Foundation. The Garden thus looks forward to serving a new group of 25 high-school biology teachers in our area. —N.H.N.

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SOME FACTS ABOUT SHAW'S GARDEN

The Missouri Botanical Garden (the official name chosen by Mr. Shaw) carries on the garden established by Henry Shaw over a century ago at TOWER GROVE, his country home. It is a private institution and has no support from city or state. The old stone walls and cast-iron fences, the Linnaean House, the Museum, the Mausoleum, and the TOWER GROVE mansion all date from Mr. Shaw's time. Since his death, as directed in his will, the Garden has been in the hands of a Board of Trustees who appoint the Director.

The Garden is open every day in the year (except New Year's and Christmas) from nine A. M. until seven P. M. spring to fall and until six in the winter time though the greenhouses close at five. TOWER GROVE, itself, Mr. Shaw's old country home, is open from one until four, admission fifty cents, with special guides. The Garden is nearly a mile long and has several entrances. The Main Entrance, the one most used by the general public, is at Tower Grove and Flora Place on the Sarah bus line (No. 42). The Park Southhampton buses (No. 80), direct from downtown, pass within three blocks of this entrance and stop directly across the street from the Administration Building at 2315 Tower Grove Avenue. The latter is the best entrance for students, visiting scientists, etc. It is open to such visitors after 8:30 A. M., but is closed on Saturdays, Sundays, and holidays. The Cleveland Avenue gate, 2221 Tower Grove, is nearly always open, and there is a service entrance on Alfred Avenue, one block south of Shaw Avenue.

Since Mr. Shaw's time an Arboretum has been developed at Gray Summit, Mo., State Highway 100 adjacent to Interstate Highway 44. It is open every day in the year and has auto roads as well as foot trails through the wild-flower reservation. There is a pinetum and an extensive display of daffodils and other narcissi which are at their best in April.